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25 March 1970

Materiel Test Procedure 9-2-201
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

BLOCK AND TACKLE

1. OBJECTIVE*

This document provides test methodology and testing techniques necessary to determine the technical performance and safety characteristics of block and tackle assemblies and associated tools and equipment as described in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), and Technical Characteristics (TC's), and to determine the item's suitability for service tests.

2. BACKGROUND

The U. S. Army in its normal shop operations requires the presence of devices which are capable of moving heavy loads through vertical displacements. These devices are classed as hoisting mechanisms and the block and tackle assembly is one type of hoist. In the assembly the block is that part which houses and provides the mounting for the rotary elements (sheaves or pulleys) and the tackle or rope (which may be either wire, natural fiber or synthetic) is the flexible element which encircles the sheaves and runs between the (2) blocks used in an assembly (see Figure 1).

The test item is a useful device because it provides force multiplication, e.g., if a load of weight (W) is to be lifted and a force (F) is available (as the pulling force capability of a human) then referring again to Figure 1, the following relation holds:

$$F = V_W \cdot \frac{W}{V_F} = \frac{\text{load}}{\text{number of ropes}} = \frac{W}{n}$$

where V_W = velocity of W

V_F = velocity of F

The purpose of testing the assembly will be to determine that it not only satisfies the general requirements of military equipment and specific requirements of its device class but that it accomplishes its primary functional purpose through effective utilization of the physical principles discussed above.

3. REQUIRED EQUIPMENT

a. Tensile Tester

*This MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal of pertinent QMR's, SDR's, TC's and any other applicable documents.

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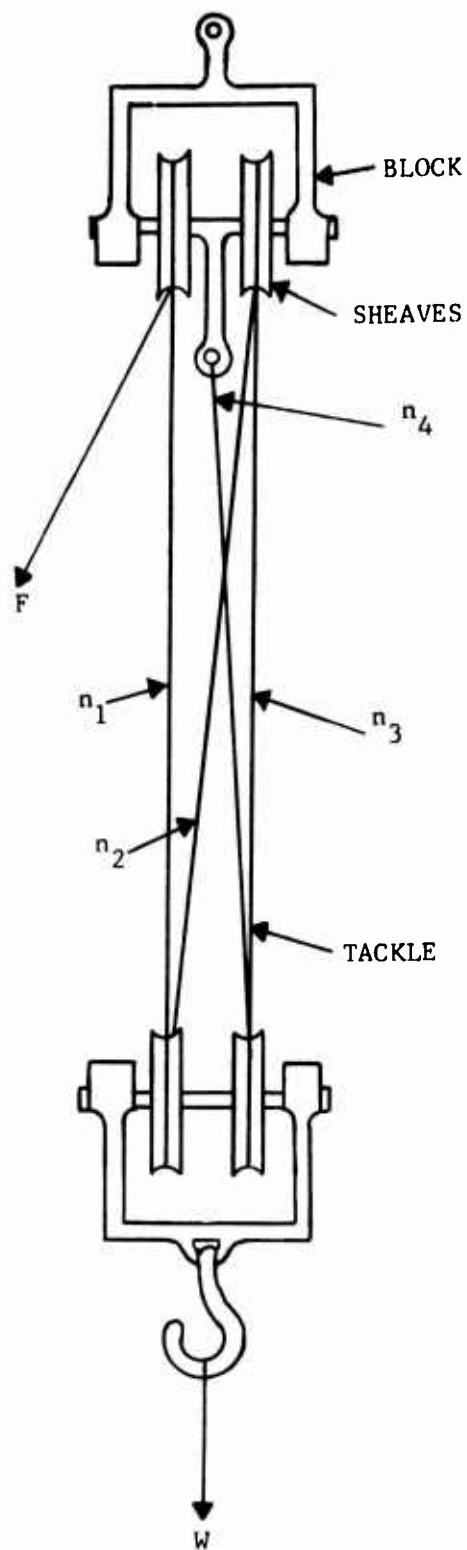


Figure 1. Typical Block and Tackle

- b. Transportation Drop Test Facility
- c. Cargo Handling Facility
- d. Spring Facility
- e. Weighing Scales
- f. Timing Devices
- g. Electrical or Electronic Programming Device
- h. Miscellaneous Hand Tools
- i. Rulers
- j. Wire Rope

4. REFERENCES

- A. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
- B. USATECOM Regulation 700-1, Value Engineering.
- C. USATECOM Regulation 705-4, Equipment Performance Report.
- D. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE).
- E. AMCP 706-134, Maintenance Guide for Design.
- F. Theodore Baumeister Marks' Mechanical Engineers' Handbook.
- G. Bolz and Hagemann, Materials Handling Handbook, Ronald Press Co. 1958.
- H. Federal Specification GGG-B-490, Blocks, Tackle (Manila Rope & Nylon).
- I. Federal Specification T-R-605, Rope, Manila and Sisal.
- J. Federal Test Methods 101B, Preservation, Packaging, and Packing.
- K. MIL-STD-129, Marking for Shipment and Storage.
- L. MIL-STD-130, Identification Marking of U. S. Military Property.
- M. MIL-STD-810, Environmental Test Methods.
- N. MIL-B-3865, Blocks, Wire and Manila Rope, Preparation for Delivery.
- O. MIL-R-15718, Rope, Wire.
- P. MIL-R-17343, Rope, Nylon.
- Q. MIL-B-24141, Block, Tackle, Wire Rope.
- R. MIL-B-24220, Block, Tackle, Synthetic Rope.
- S. MTP 9-2-503, Durability.
- T. MTP 10-2-500, Physical Characteristics.
- U. MTP 10-2-501, Operator Training and Familiarization.
- V. MTP 10-2-503, Surface Transportability (General Supplies and Equipment).
- W. MTP 10-2-505, Human Factors Evaluation.
- X. MTP 10-2-507, Maintenance Evaluation.
- Y. MTP 10-2-508, Safety.
- Z. MTP 10-2-511, Quality Assurance.
- AA. MTP 10-2-512, Reliability.

5. SCOPE

5.1 SUMMARY

This materiel test procedure describes the following tests to be conducted on block and tackle assemblies:

- a. Preparation for Test - A determination of the condition of the

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test item upon its arrival and other preparatory procedures to be completed prior to the start of active testing. These will include the following:

- 1) Packaging, Preservation, and test item inspection
- 2) Inventory check
- 3) Physical characteristics
- 4) Operator training and familiarization
- 5) Pre-operational checks

b. Operational Performance - An evaluation to determine specific operational design characteristics including the test item's capability to perform its primary function.

c. Durability - An evaluation of the test item's capability to display original physical and performance characteristics after an extended period of continuous operation.

d. Transportability - An evaluation to determine the capability of the test item and its container to withstand the forces which it will experience during normal handling, transporting, and use.

e. Maintenance - An evaluation to determine and appraise the test item's maintenance characteristics and requirements, a verification and appraisal of its malfunctions, an evaluation of the test item's associated publications and other common and special support elements (maintenance test package), an appraisal of the test item's design for maintainability (AMCP 706-134: accessibility, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculation of indicators which express the effects of appropriate preceding aspects.

f. Safety - An evaluation to determine the safety characteristics and possible hazards of the test item.

g. Human Factors - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

h. Value Analysis - An evaluation directed at analyzing the primary functions and features of the test item for the purpose of reducing the cost of the test item without compromising the desired performance and safety characteristics.

i. Quality Assurance - A study to determine the quality of the test item.

5.2 LIMITATIONS

The tests contained in this document as applicable for the engineering evaluation of wooden or metal multi-sheaved blocks equipped with rope (tackle) made of metal, synthetics or natural fiber.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

6.1.1.1 Shipping and Packaging Inspections

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a. Examine the shipping method, preservation and packaging and determine any non-conformance with MIL-B-3865. The container shall also be marked in accordance with MIL-STD-129.

b. Record the following:

- 1) Evidence of damage or deterioration to packaging or shipping components and materials.
- 2) All identification markings.

c. Remove the test item from its shipping carrier, or container, and record the following:

- 1) All printed material accompanying the test item and agreement with test item markings.
- 2) Equipment, time and personnel required.
- 3) Comments regarding the method and materials used to secure the test item.

6.1.1.2 Test Item Inspection

The test item shall be visually inspected for evidence of defects, damage, wear in its manufacturing, materials, and workmanship, and for markings in accordance with MIL-STD-130. In particular, the following will be considered:

a. Metal surfaces should be treated for rust and/or painted in accordance with the best commercial practice. Paint should be smooth and uniform without runs and sags.

b. Component junctions:

- 1) Rivets should be of a size to completely fill holes and allow for a sufficient flare over.
- 2) Welding should be free from slag, cracks, fractures and have a smooth, clean appearance.
- 3) Hardware should be of sufficient size and strength and be tightly drawn.
- 4) Seams, joints and edges should have a good fit and alignment and there shall be no sharp edges or burrs.

6.1.2 Inventory Check

Verify completeness of the test item and associated maintenance test package, parts and material with the Basic Issue Item List (BIIL) and file an Equipment Performance Report (EPR) if required.

6.1.3 Physical Characteristics

The physical characteristics of the test item shall be determined by performing the applicable sections of MTP 10-2-500, in particular the following:

a. Code Markings - Note the legibility of test item markings and record all data.

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b. Dimensional Data - Record the dimensions of all blocks and the tackle.

c. Test Item Characteristics - Record the following:

- 1) Block Material
- 2) Number of sheaves per block
- 3) Weight of the complete assembly
- 4) Safe Working Load (SWL)
- 5) Rope (tackle data):
 - a) Type
 - b) Diameter
 - c) Construction - lay, number of strands, etc.
 - d) Length

6) Locking mechanism used (if any)

d. Verify that assembly components are in accordance with the following standards:

- 1) Wire rope tackle blocks - MIL-B-24141
- 2) Synthetic rope tackle block - MIL-B-24220
- 3) Manila rope tackle block - GGG-B-490D
- 4) Manila rope - T-R-605B
- 5) Wire rope - MIL-R-15718
- 6) Nylon rope - MIL-R-17343

6.1.4 Operator Training and Familiarization

Orient test personnel using the criteria of MTP 10-2-501 and record all pertinent data.

6.1.5 Pre-Operational Checks

Perform the following:

- a. Depreservation and assembly - remove all preservation from the test item and attach any devices, etc. which are removed from the test item for transporting convenience.
- b. Lubrication - verify complete lubrication of the test item.
- c. Sheave check - rotate each sheave individually and note the absence of binding or rubbing.
- d. Tackle check - examine the rope over its entire length for broken strands or fraying.

6.2 TEST CONDUCT

- NOTE:
1. Prepare an Equipment Performance Report for all equipment failures.
 2. During the conduct of all tests, test personnel shall observe the proper safety precautions and, in particular,

shall adhere closely to the technical manual instructions for the handling and use of the test item.

6.2.1 Operational Performance

6.2.1.1 Rope Tensile Strength

Perform the following utilizing a tensile testing machine capable of applying twice the Safe Working Load (SWL) of the block-tackle assembly.

a. Detach the rope from the assembly, secure one end to the fixed head of the machine, then attach an appropriate length, without slack, to the moving head.

b. Subject the rope to a tension (T) of:

$$\frac{2}{n} \cdot (\text{SWL}) \quad \text{lbs.}$$

where n is equal to the number of ropes interconnecting the blocks in the assembly.

c. Record the tension, in pounds.

d. Hold the rope under tension for (10) minutes and record the elongation in inches.

e. Remove the rope from the machine, and examine for breaks or fraying.

f. Measure and record the amount of permanent stretch in inches.

6.2.1.2 Block Strength Test

Test each block of the assembly by the following:

a. Secure the hook of the block to the movable head of the machine by a suitable link or shackle. (The block supplied with the anchor hook will have the anchor hook secured).

b. Secure the fixed head of the machine to the block by a curved steel bar(s) or wire rope(s) of suitable diameter which fits around and contacts approximately 180° of each sheave surface.

c. Apply a tension of (2 · SWL) lbs.

d. Hold the tension for (5) minutes.

e. Release the block and determine if there has been any permanent deformation, cracking, breaks, etc.

6.2.1.3 Composite Test (Including Mechanical Advantage)

Perform the following on the complete assembly:

a. Attach the non-load end block to a fixed overhead point and a test load (W1) equal in pounds to the SWL of the assembly to the load end block.

b. Connect a spring scale to the in-line connection of the "F" line of the assembly and gradually increase the pulling force, noting the scale reading when the load begins its vertical motion. Record this force (F1) in lbs.

c. Raise and lower the load at approximately 3 feet/minute for (5) cycles.

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d. If the assembly has a snubbing hook or load locking device, operate the device with the load at maximum vertical displacement and hold the load stationary for (3) minutes.

e. Release the load and examine the blocks, tackle splices, etc. for damage.

6.2.2 Durability

Perform the applicable portions of MTP 9-2-503 and the following:

a. Set up the test item as prescribed in paragraph 6.2.1.3 with the SWL load attached.

b. Attach the pulling end of the assembly to a device which is capable of raising and lowering the load automatically at a variable rate. A suggested means for accomplishing this would be a take-up reel powered by a reversible variable speed motor which is controlled in turn by an electrical programmable cam assembly.

c. Set the motor speed for a load displacement of 3 feet/minute and adjust the programmer to reverse the motor direction at the (2) points of maximum load travel.

d. Run the test for (5) consecutive hours.

e. When the test is complete examine the complete assembly for any damage or signs of accelerated wear.

f. For each defect revealed by step e. record the nature of the defect and location. In the event the above-mentioned test facility is not used, arrange a manual procedure which will provide equivalent effort and mission time.

NOTE: In the event of equipment malfunction during the durability test, the procedures of the maintenance section of the technical manual will be performed and the durability test rerun following repair.

6.2.3 Transportability

Perform the applicable sections of MTP 10-2-503 and the following:

a. Prepare the test item for normal transport.

b. Subject the test item to test procedures in accordance with and at a facility described in Federal Test Method Standard 101B, Method 5007. (This test is normally limited to containers with gross weight less than 200 pounds and no dimension over 60 inches. If the test item is larger, use MIL-STD-810B).

c. Upon completion of the test perform the following:

- 1) Examine and record the extent of physical damage which the exterior of the test item container exhibits.
- 2) Remove the test item from its container. Observe and record the following:

- a) Broken bracing or damaged packing material
- b) Undesirable shifting in the contents

c) Loose, free or broken materials or components

d. Visually inspect the test item for damage, and operate it under normal conditions to determine if there has been any change in its operating efficiency.

6.2.4 Maintenance

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 and MTP 10-2-512 with emphasis on the following:

a. Organizational (O), Direct Support (F), and General Support (H) Maintenance requirements.

- b. Operator through General Support Maintenance Literature.
- c. Repair parts.
- d. Tools.
- e. Test and handling equipment.
- f. Calibration and maintenance facilities.
- g. Personnel skill requirements.
- h. Maintainability.
- i. Reliability.
- j. Availability.

6.2.5 Safety

a. Determine the safety characteristics of the test item as described in the applicable sections of MTP 10-2-508.

b. Throughout the test personnel shall observe and record the following:

- 1) Any dangerous or unsafe conditions, any conditions that might present a safety hazard.
- 2) Inoperative or malfunctioning safety features.

c. Subject load holding and locking devices to a minimum of 5 cycles of load holding and release operations of 1 minute duration and record any deficiencies.

6.2.6 Human Factors Evaluation

Throughout the test, evaluate the effectiveness and characteristics of the man-item interaction as related to human factors by performing the applicable sections of MTP 10-2-505, and the following:

a. Prepare checklists to evaluate the human factor characteristics using Human Factors Evaluation Data for General Equipment (HEDGE) for the Class IIIA equipment (man operated materiel Handlers) including the following:

1) Operability:

- a) Engage load - evaluate design for bringing into contact with the load.

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b) Lift, move load - evaluate design for performance of operation.

2) Maintainability:

- a) Perform preventative maintenance - evaluate lubrication procedures.
- b) Remove and replace - evaluate the ease of sheave replacement.

3) Transportability:

- a) Place in transit configuration - evaluate procedures required to prepare test item.
- b) Packaging - evaluate the packaging procedures.
- c) Place on carrier - evaluate ease of placing test item/package onto/in carrier.

4) Erectability - evaluate the problems associated with the selection and requirements of an erection or hanging location.

b. Evaluation of the tasks of step a shall include but not be limited to the following:

- 1) Adequacy of instructions and tools to perform the task
- 2) Mental and physical effort required
- 3) Design of the test item as it affects the task
- 4) Time required for the task
- 5) Personnel required for the task

6.2.7 Value Analysis

During the conduct of all tests, personnel shall examine the materials, construction, and design of the test item from a value standpoint in an effort to affect cost reduction of the test item. USATECOM Regulation 700-1 shall serve as a basis for this evaluation. Perform the following:

a. Examine the test item in the following cost reduction areas:

- 1) Deletion of ineffective or unnecessary features or components.
- 2) Substitution of less expensive but comparable component or material.
- 3) Changes in the design to reduce the cost of manufacturing.

b. Examine all proposals to determine that the performance and safety characteristics have not been lowered.

c. Record the following for each suggested change:

- 1) Component or feature involved
- 2) Suggested change
- 3) Reasons for the suggestion

6.2.8 Quality Assurance

Determine the quality of the test item as described in the applicable section of MTP 10-2-511.

6.3 TEST DATA

NOTE: In compiling the Test Data section, test personnel should expound upon those data procedures which are other than quantitative in nature by recording narrative descriptions which will provide full details of conditions and/or events occurring during the conduct of the test.

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

6.3.1.1.1 Shipping and Packaging Inspection -

Record the following:

- a. Any noncompliance with the standards for shipping, marking, preservation, and packaging.
- b. Evidence of damage, identification markings, and list of printed matter enclosed.
- c. Equipment, time, and personnel required to unpack the test item and comments concerning the method and materials used in packing.
- d. List of printed material accompanying the test item.

6.3.1.1.2 Test Item Inspection -

Record the following:

- a. Any instances of noncompliance with the marking requirements of MIL-STD-130.
- b. Evidence of defects in the manufacturing, materials, and workmanship.

6.3.1.2 Inventory Check

List any materials missing from the Basic Issue Item List.

6.3.1.3 Physical Characteristics

Record the data required by MTP 10-2-500 and the following:

- a. Test item code markings.
- b. Dimensional data.
- c. Class characteristics:

- 1) Block material

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- 2) Number of sheaves per block
- 3) Weight of the complete assembly
- 4) Safe working load (SWL)
- 5) Rope (tackle data):
 - a) Type
 - b) Diameter, in inches
 - c) Construction - lay, strands, etc.
 - d) Length, in feet

- 6) Any locking mechanisms used

d. Any instances where components are not in accordance with listed specifications.

6.3.1.4 Operator Training and Familiarization

Record the data collected as described in applicable sections of MTP 10-2-501.

6.3.1.5 Pre-Operational Checks

Record the following:

- a. Depreservation procedures utilized
- b. Any assembly required
- c. Lubrication procedures
- d. Any sheaves which bind or rub
- e. Defective tackle

6.3.2 Test Conduct

6.3.2.1 Operational Performance

6.3.2.1.1 Rope Tensile Strength -

Record the following:

- a. The tension (T) in pounds used
- b. The number of ropes in the assembly
- c. Rope elongation in inches under tension
- d. Permanent stretch, in inches
- e. Signs of damage

6.3.2.1.2 Block Strength Test -

Record the following:

- a. The tension in pounds used in the test
- b. Damage to the block

6.3.2.1.3 Composite Tests -

Record the following:

- a. The test load (SWL) in pounds
- b. The applied lifting force (F1) in pounds
- c. Any problems with the locking device
- d. Signs of damage to the assembly

6.3.2.2 Durability

Record the data required by MTP 9-2-503 and the following:

- a. The length of test in hours
- b. Damage to any component, material or finish

6.3.2.3 Transportability

Record data collected as described in the applicable sections of MTP 10-2-503.

- a. Drop test data collected as described in the applicable sections of Federal Test Method 101B (MIL-STD-810B).
- b. The locations and types of damage which the test item container exhibits and any breakage, shifting, etc. of the container contents.
- c. Any damage to the test item or impairment of its operating efficiency. Include details as to location and nature of the fault.

6.3.2.4 Maintenance

Record the data collected as described in applicable sections of MTP 10-2-507 and MTP 10-2-512.

6.3.2.5 Safety

Record data collected as described in the applicable sections of MTP 10-2-508, and the following:

- a. Any instances of unsafe conditions revealed during the conduct of any test.
- b. Load holding or locking devices which do not function properly.

6.3.2.6 Human Factors Evaluation

Record the following:

- a. Data collected as described in applicable sections of MTP 10-2-505
- b. Test personnel responses to checklist

6.3.2.7 Value Analysis

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Record the following:

- a. The component or feature involved
- b. Suggested change
- c. Reasons for suggested change

6.3.2.8 Quality Assurance

Record data collected as described in the applicable section of MTP 10-2-511.

6.4 DATA REDUCTION AND PRESENTATION

Determine the mechanical advantage by the following:

$$\text{Mechanical advantage} = \frac{W1}{F1}$$

Compare this figure with the number of ropes, n, and compute the percentage difference.

Tabulate and summarize the remaining data as appropriate. All data shall be compared with the technical performance characteristics specified in the QMR's, SDR's, or other specifications.

A Safety Release Recommendation shall be submitted in accordance with USATECOM Regulation 385-6 based on the data collected related to safety.

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13. ABSTRACT This Engineering Test Procedure describes test methods and techniques for evaluating the technical performance and characteristics of Block and Tackle Assemblies, and for determining their suitability to undergo test for service use by the US Army. The evaluation is related to criteria expressed in ap- plicable Qualitative Materiel Requirements (QMR), Small Development Require- ments (SDR), Technical Characteristics (TC), or other appropriate design re- quirements and specifications.		

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